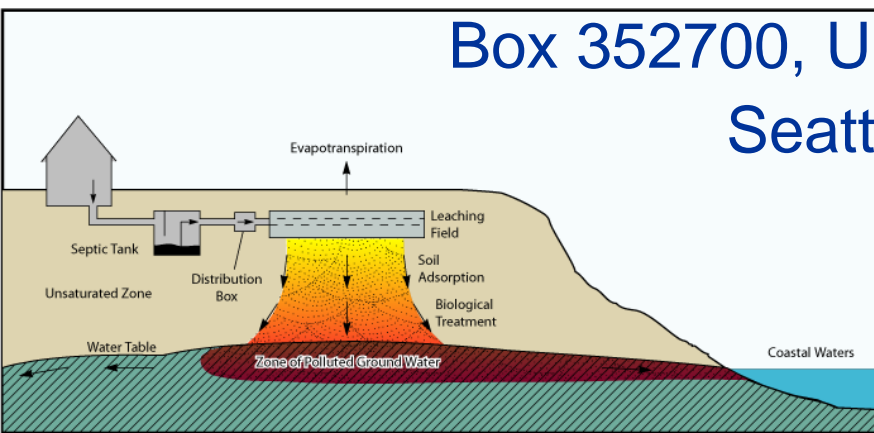




A Field Trial of Inexpensive Nonproprietary OSS Designs for Nitrogen Removal

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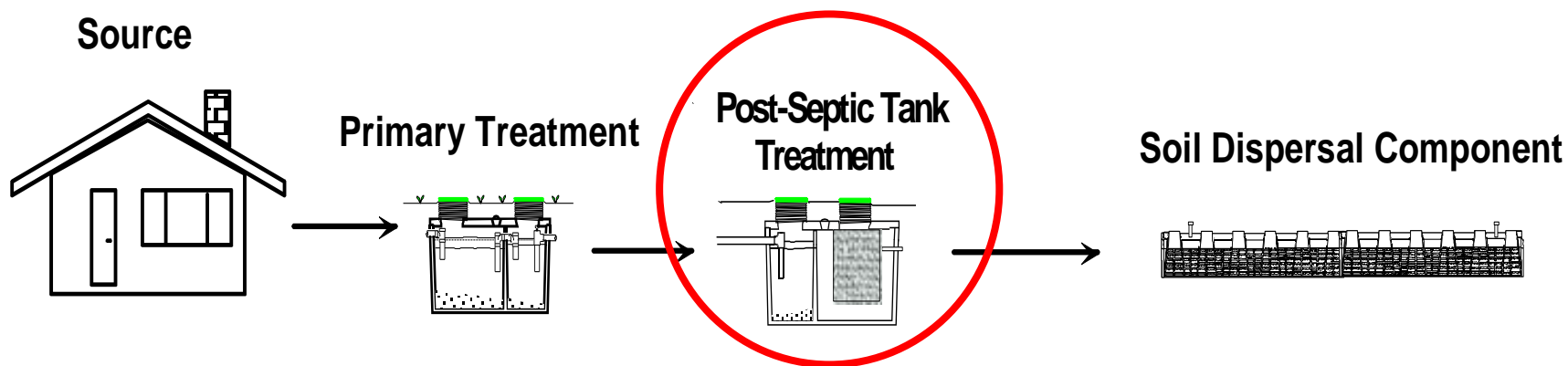
Study Partners





Wastewater Nitrogen Management Approaches

- Source diversion
- Post-septic tank treatment
- Design of the soil dispersal component (drainfield)





OSS Nitrogen Removal Project Design

- Problems:
 - N removals OSS are highly variable
 - Limited treatment options
 - Regional environmental and water source affects on N removal not well-known



OSS Nitrogen Removal Project Design

- Objectives:
 - Maximize N removal efficiencies
 - Verify performance objective (<20 mg/L TN full test avg.)
 - Expand reliable, affordable options



ETV-Nutrient Reduction Protocol

- Minimum of 12 consecutive months
- Daily Design loading 480 gpd (100% \pm 10% of the rated capacity)
 - 6 AM – 9 AM: ~35% of flow
 - 11 AM – 2 PM: ~25% of flow
 - 5 PM – 8 PM: ~40% of flow
- Stress Testing (effect of home activities)
 - washday loading
 - working parent
 - low-loading
 - power/equipment failure
 - one week vacation

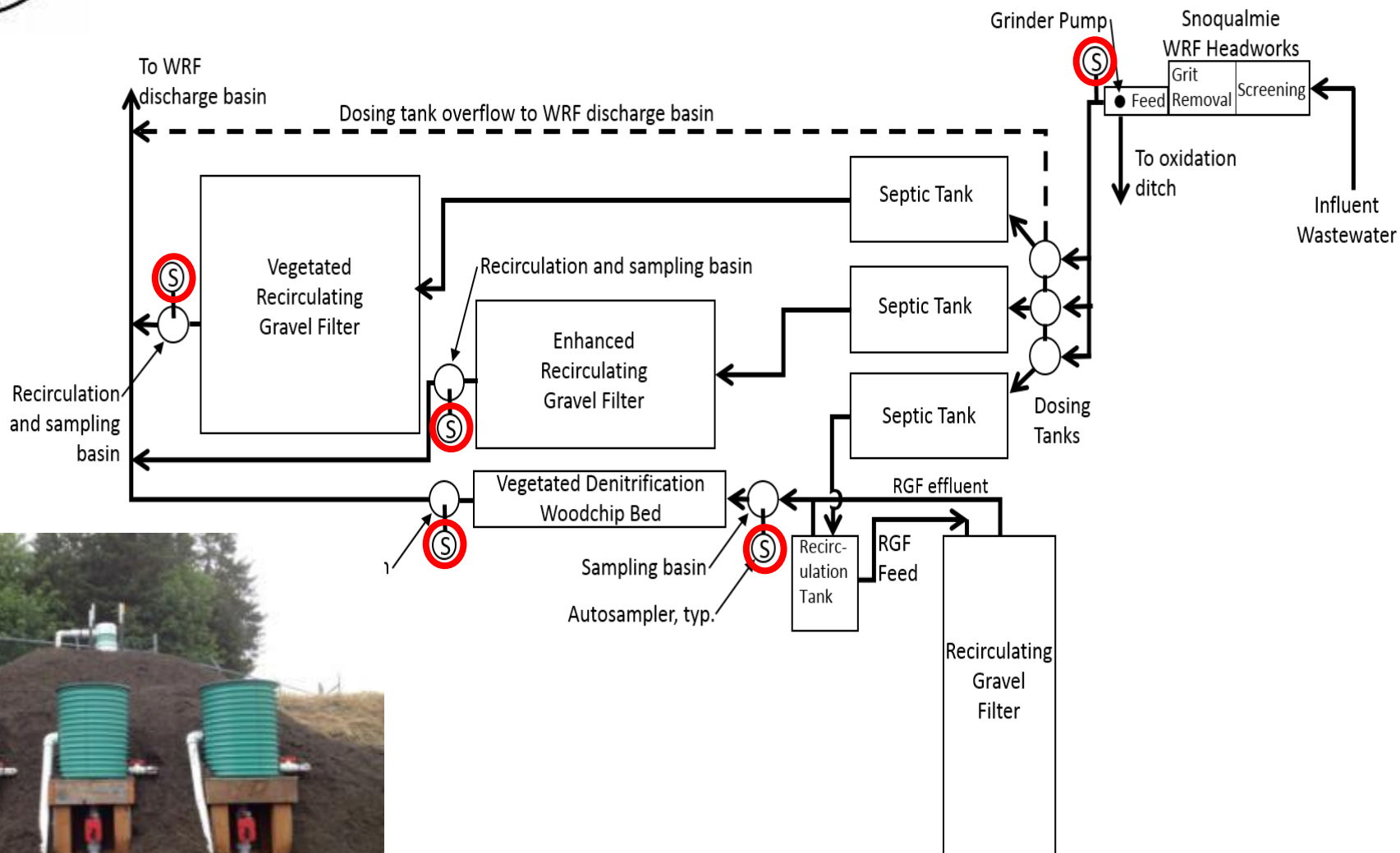


Snoqualmie WWTP Test Site





Snoqualmie WWTP Test Site w/autosampler locations

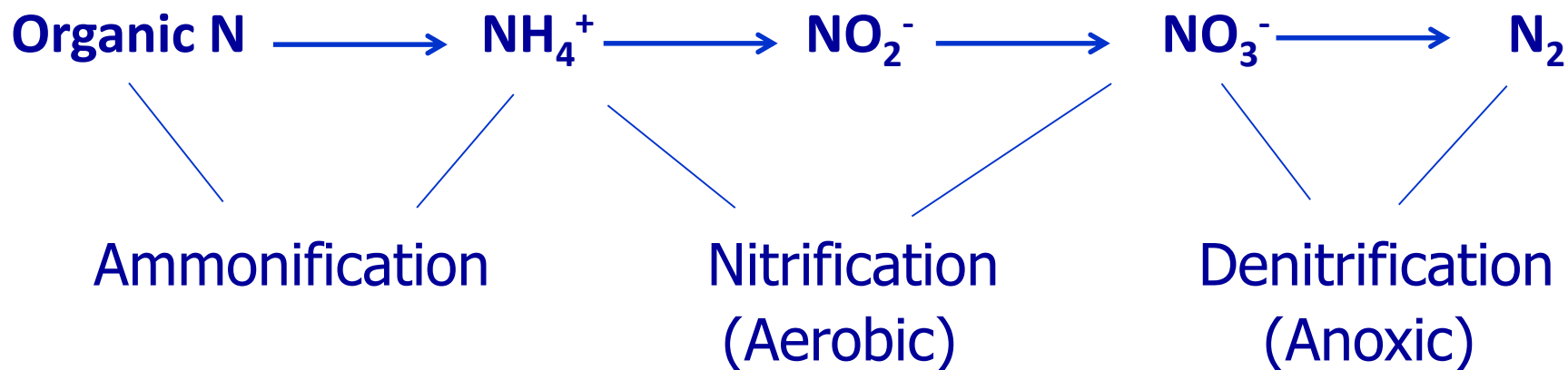




Nitrogen Biochemical Transformations

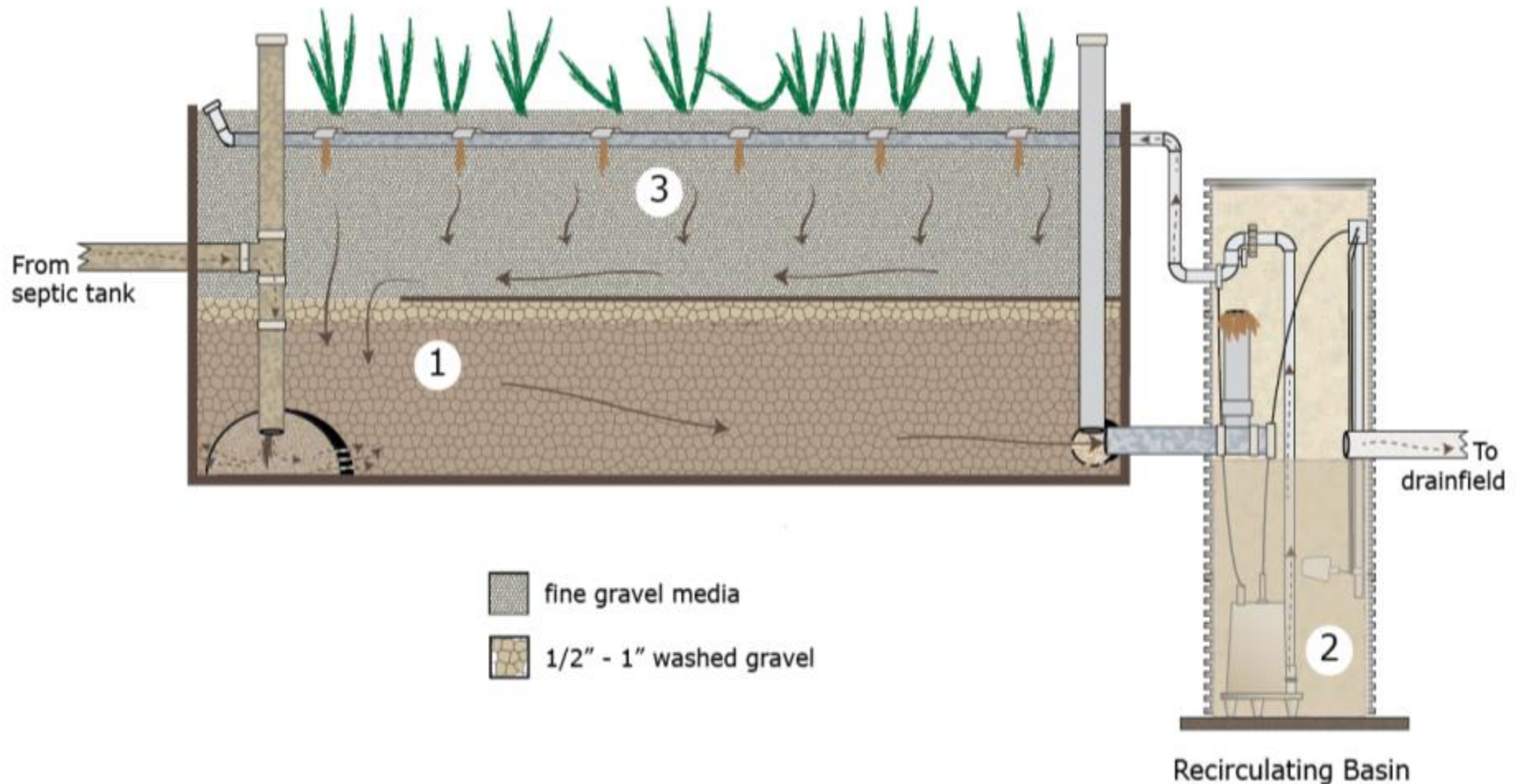
Two step process:

- 1) Nitrification - "nitrifies NH_4^+ to NO_3^- "
- 2) Denitrification - reduces NO_3^- to nitrogen gas



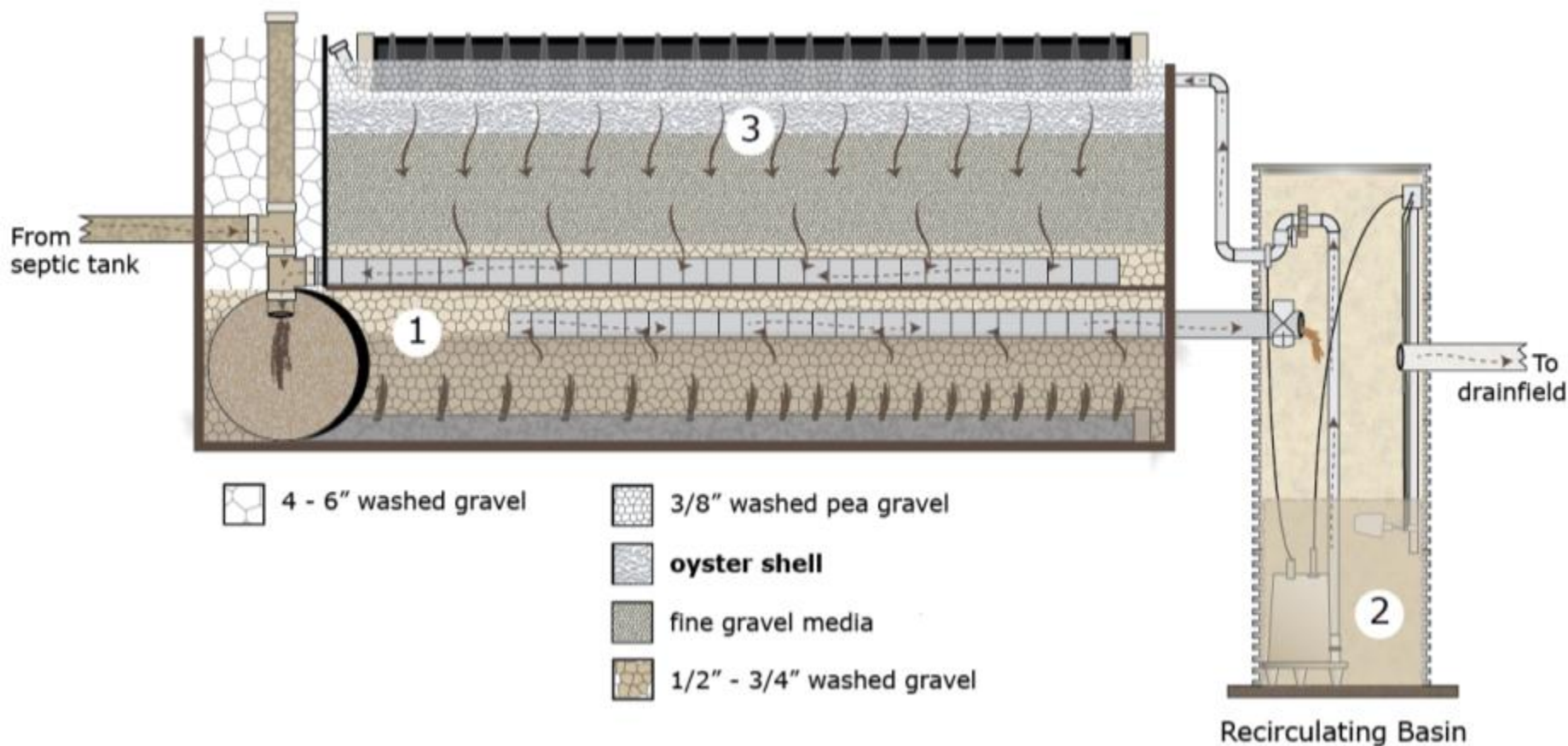


Vegetated Recirculating Gravel Filter (VRGF)





Enhanced Recirculating Gravel Filter (ERGF)





ERGF



July 2012



January 2013



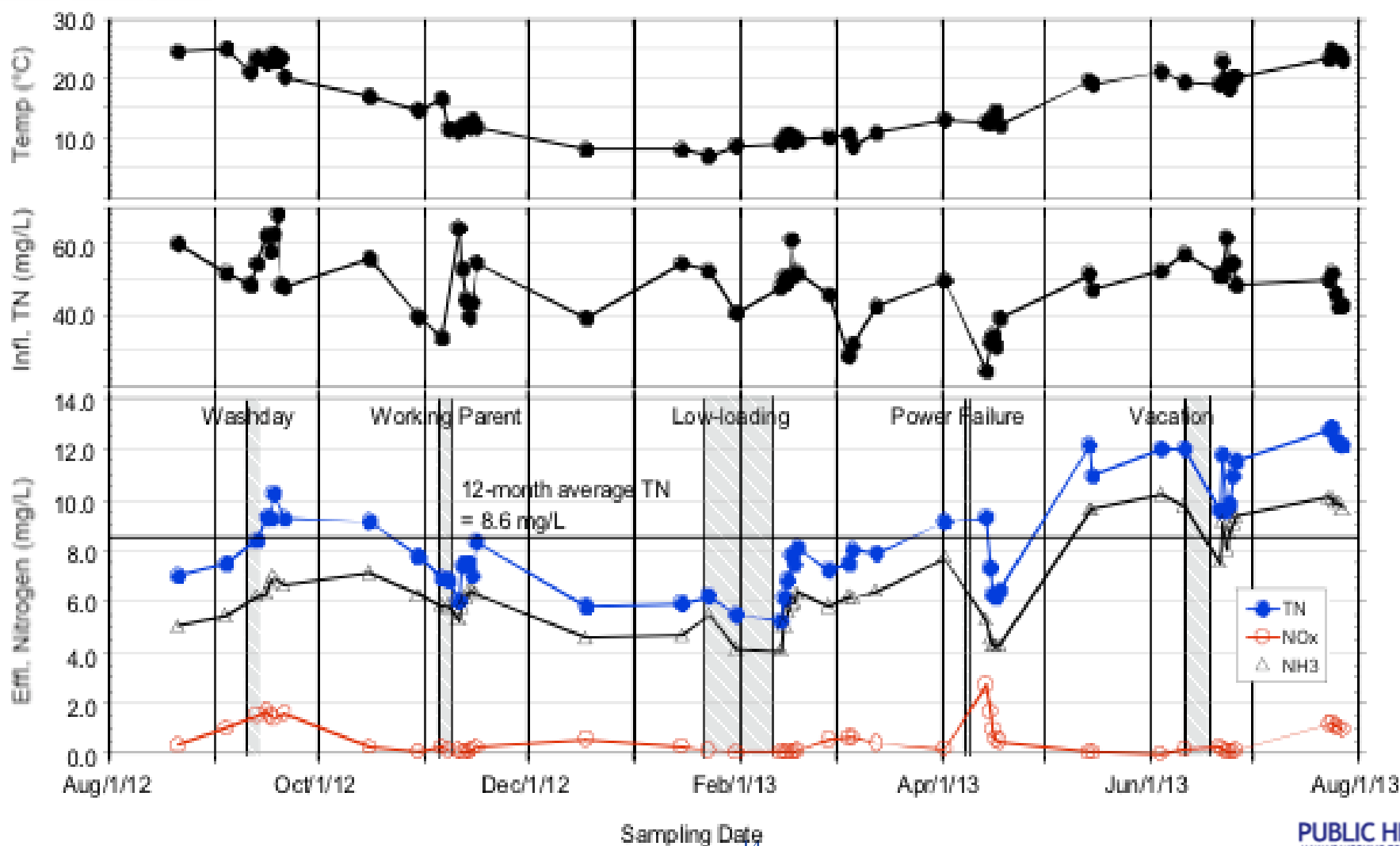
Average Performance for ERGF Over 12-Month Test (82.3% TN Removal)

Parameter	units	Influent	Effluent
Total N	mg/L	48.6 (9.5)	8.6 (2.2)
NH ₃ -N	mg/L	29.3 (5.3)	6.8 (1.9)
NO _x -N	mg/L	-	0.6 (0.6)
Org-N	mg/L	-	1.3 (0.5)
BOD/CBOD*	mg/L	314 (98)	8.6 (1.9)
TSS	mg/L	354 (137)	5.3 (2.2)
VSS	mg/L	324 (131)	4.4 (2.0)
COD/SCOD*	mg/L	715 (223)	24.6 (5.7)
Total Phosphorus	mg/L	5.8 (1.3)	3.5 (1.4)
Fecal Coliform**	CFU/100 mL	8.4E+6	4.6E+5
Alkalinity as CaCO ₃	mg/L	231 (36)	203 (27)
pH		7.4 (0.3)	6.9 (0.2)

*Effluents, **Geometric mean, () is standard deviation

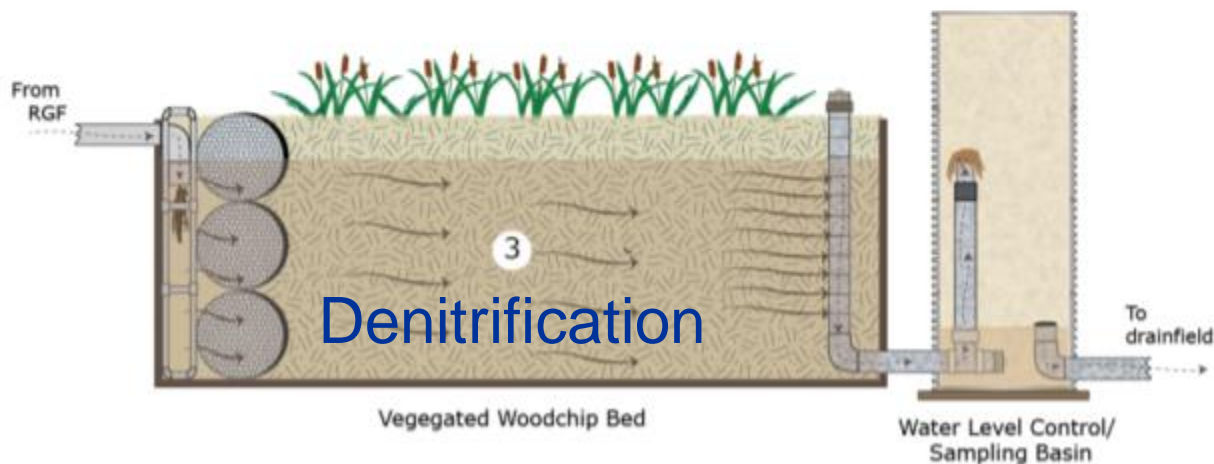
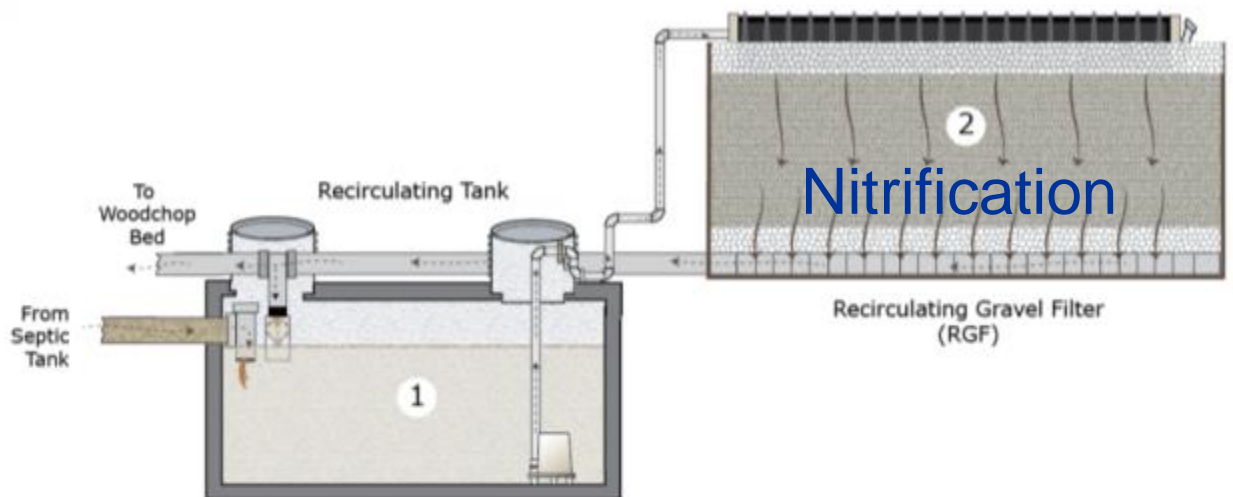


ERGF Influent and Effluent Nitrogen Over 12-Month Test Period





Recirculating Gravel Filter (RGF) & Woodchip Bed - Two Stage System





RGF & Woodchip Bed



August 2012



June 2013



RGF & Woodchip Bed





Average Performance for RGF-Woodchip Bed Over 12-Month Test Period

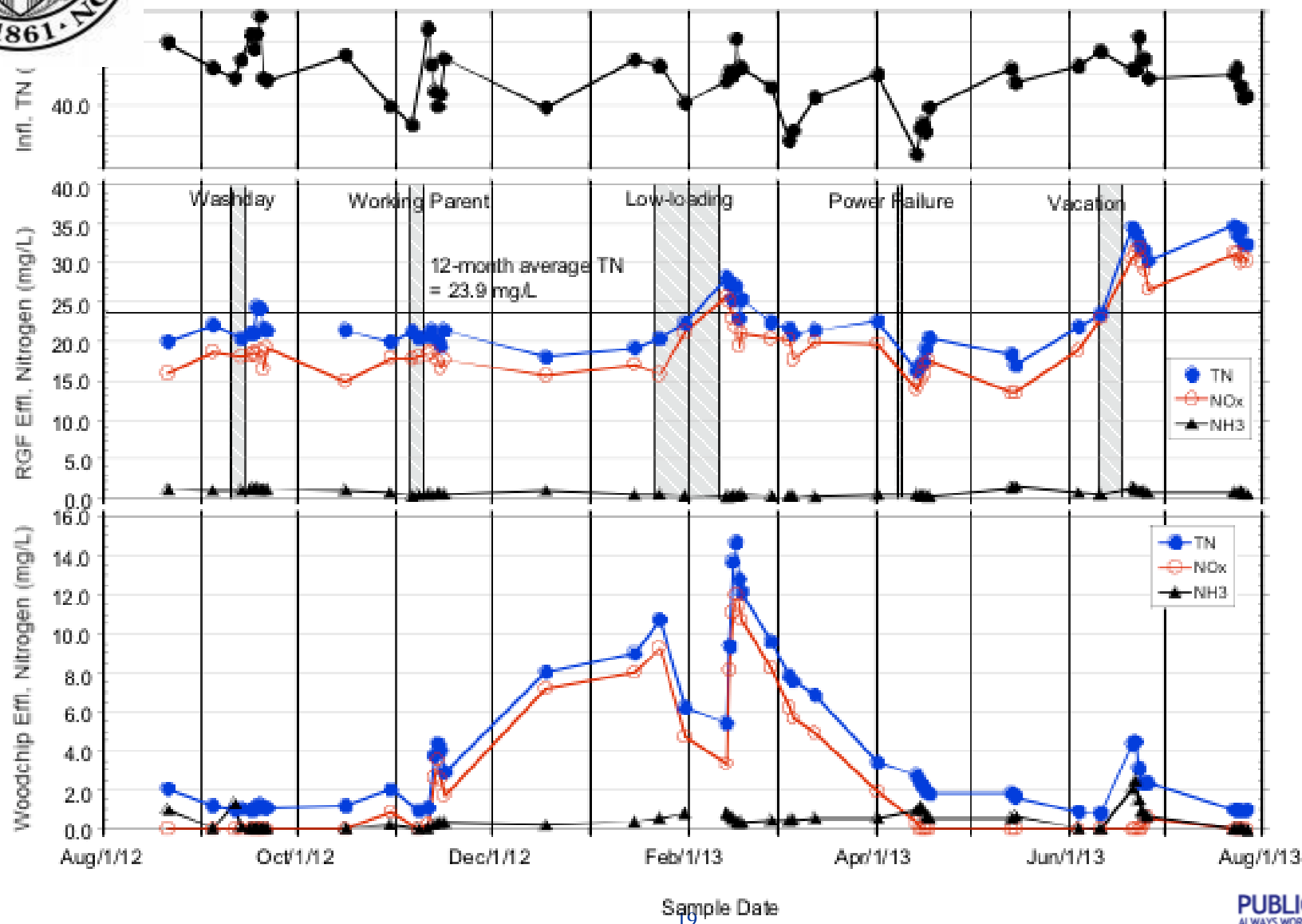
91.8% TN Removal and 960 CFU/100 mL effluent fecal coliform)

Parameter	units	Influent	RGF Effluent Average	Woodchip Effluent
Total N	mg/L	48.6 (9.5)	23.9 (5.4)	4.0 (3.8)
NH ₃ -N	mg/L	29.3 (5.3)	0.7 (0.4)	0.5 (0.5)
NO _x -N	mg/L	-	21 (5.5)	2.4 (3.7)
Org-N	mg/L	-	2.2 (1.2)	1.1 (0.3)
BOD/CBOD*	mg/L	314 (97.8)	4.7 (2.6)	10.8 (14.1)
TSS	mg/L	354 (137)	10.1 (12.7)	2.1 (2.0)
VSS	mg/L	324 (131)	5.8 (5.5)	0.9 (2.3)
COD/SCOD*	mg/L	715 (223)	21.6 (5.5)	37.6 (20.7)
Total Phosphorus	mg/L	5.8 (1.3)	-	3.4 (1.9)
Fecal Coliform**	CFU/100 mL	8.4E+6	1.6E+05	0.96E+03
Alkalinity as CaCO ₃	mg/L	231 (36)	84 (28)	154 (36.6)
pH		7.4 (0.3)	6.8 (0.3)	6.6 (0.2)

*Effluents, **Geometric mean, () is standard deviation

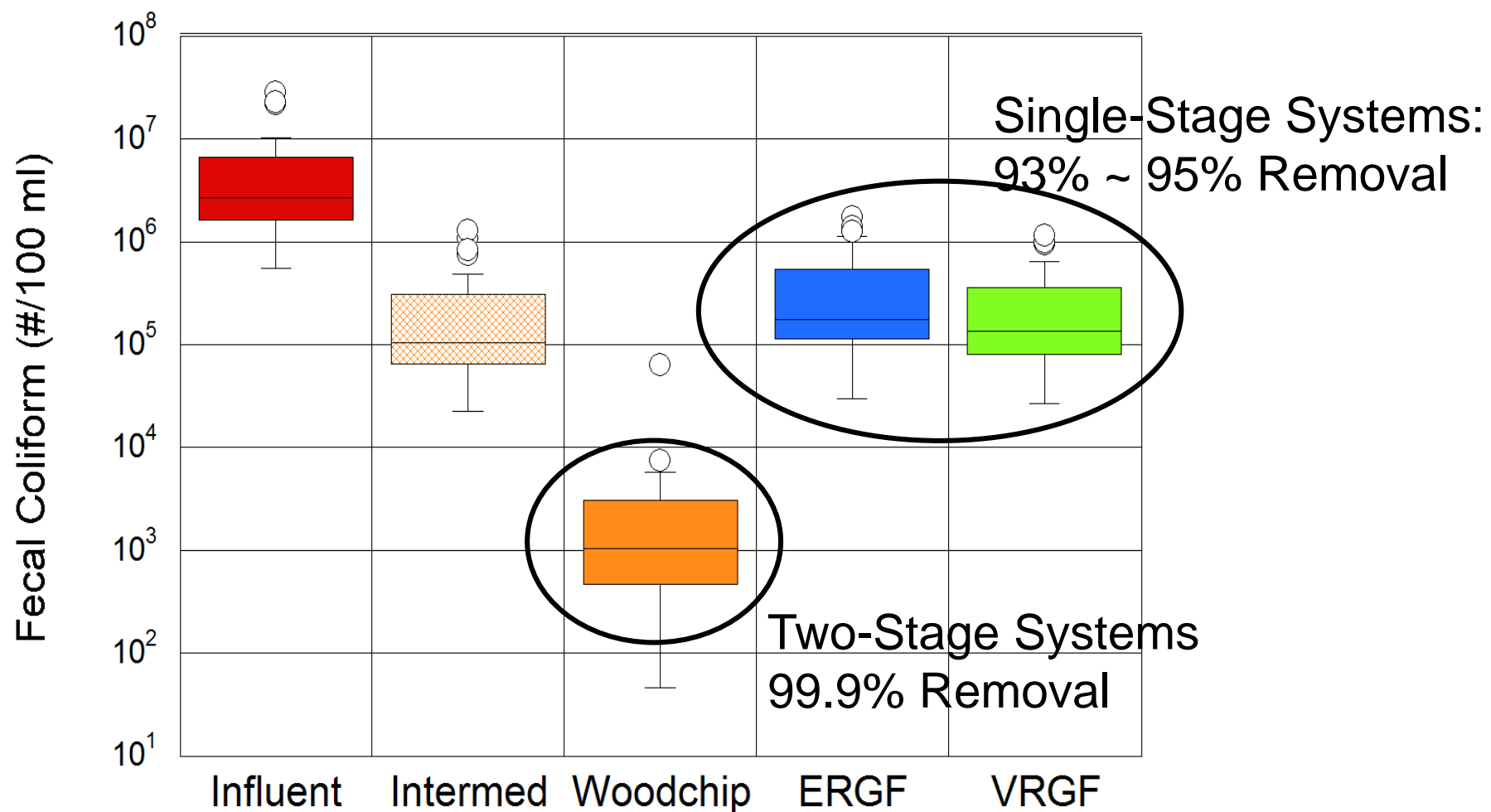


Nitrogen Removal in RGF and Woodchip Bed Over 12-Month Test Period



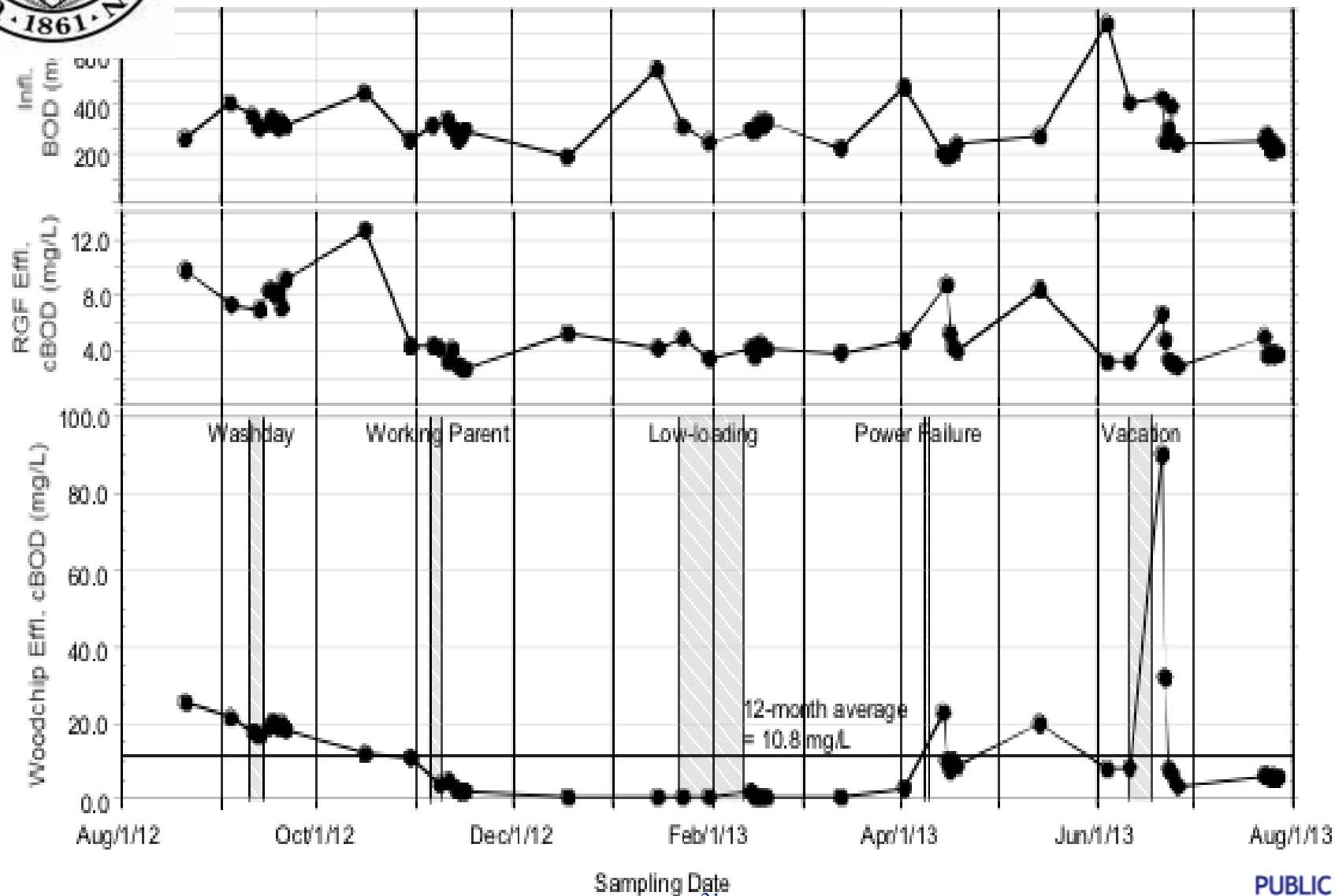


Fecal Coliform (Aug 2012 – Feb 2013)





CBOD in RGF and Woodchip Bed Effluents Over 12-Month Test Period





Project Outcomes

1. Webpage posting the ETV Reports summarizing the results from the 3 systems
2. Provide technical support for Hood Canal On-Site Sewage System Nitrogen Reduction (HCOSSEN) demonstration project
3. Complete RS&Gs for the RGF/Woodchip Bed and the VRGF systems

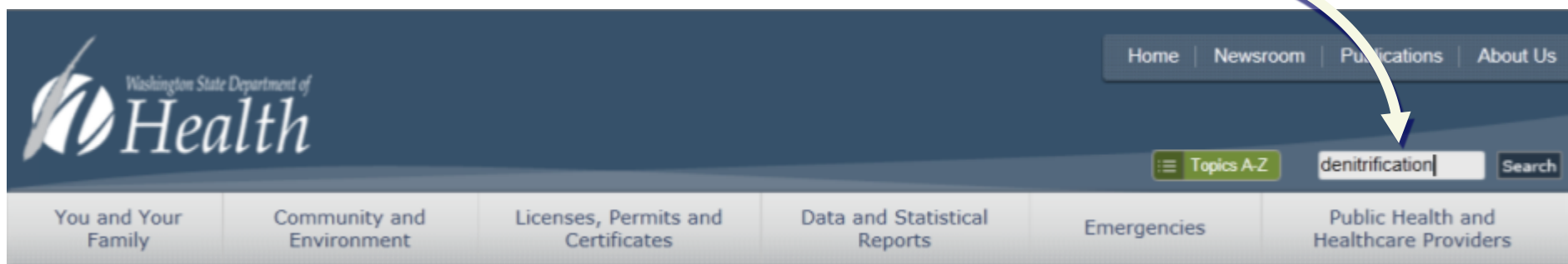


Comparison of the 3 Nitrogen Removal Systems

Parameter	Unit	Vegetated RGF	Enhanced RGF	RGF/ Woodchip Bed
Total Area	ft ²	256	180	221
Treatment Media Depth	ft	3.5	3.5	2.0-RGF 2.8-Woodchip Bed
Average Effluent TN	mg/L	15.1	8.6	4.0
Average TN removal	%	68.8	82.3	91.8



To learn more about the project go to
www.doh.wa.gov
search for Denitrification





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Lyle Beach - Laboratory Analyst
Brian Richardson - Senior Operator
- Peter Lombardi, Orenco Systems Inc.
- Dennis Hallahan, Infiltrator Systems Inc.